November 30, 2001

Members of the Senate Energy, Utilities and Communications Committee
Members of the Senate Budget and Fiscal Review Committee
Members of the Senate Appropriations Committee
Members of the Assembly Utilities and Commerce Committee
Members of the Assembly Budget Committee
Members of the Assembly Appropriations Committee
California State Capitol Building
Sacramento, California 95814

The California Energy Commission's Semi-Annual Report Concerning
The Public Interest Energy Research Program

Dear Members:

In accordance with Public Resources Code Section 25620.5(h), the California Energy Commission hereby transmits its Semi-Annual Report regarding the Public Interest Energy Research (PIER) Program for the period May 1, 2001 through October 31, 2001. (The Legislative Analyst has requested that all PIER Program semi-annual reports be submitted on or before June 1 and December 1 of each year.) The enclosed report provides the required evaluation of the progress and a status of the PIER Program's implementation for this reporting period.

The Energy Commission is continuing to make substantial progress in meeting the goals of the PIER Program, as demonstrated by the results of PIER-funded projects that will advance science and technology to improve the quality of life for California citizens. Should you have questions or comments concerning this report, please feel free to contact Tim Schmelzer, Assistant Director in the Energy Commission's Office of Governmental Affairs, at 654-4942.

Respectfully submitted,

ARTHUR H. ROSENFELD
Commissioner and Presiding Member
Research, Development and
Demonstration Committee

ROBERT A. LAURIE
Commissioner and Associate Member
Research, Development and
Demonstration Committee

Enclosure
cc: Legislative Analyst's Office

California Energy Commissions Semi-Annual Report Concerning the Public Interest Energy Research Program (May 1, 2001, through October 31, 2001)

In accordance with Public Resources Code (PRC) Section 25620.5(h), this document constitutes the California Energy Commission's *Semi-Annual Report* for the Public Interest Energy Research (PIER) Program, covering the period from May 1, 2001, through October 31, 2001. (The Legislative Analyst has requested that all PIER Program semi-annual reports be submitted on or before June 1 and December 1 of each year.)

This report provides the required "evaluation of the progress and a status of the PIER Program's implementation" for this six-month period. It also provides input for the Energy Commission's more detailed *Annual Report Concerning the Public Interest Energy Research Program* (hereafter referred to as *Annual PIER Report*) required pursuant to PRC Section 25620.8.

I. SUMMARY STATUS OF THE PIER PROGRAM

During this reporting period, the PIER Program accomplished the following:

- The **Renewables** program area awarded over $35 million in funding to renewable energy research and development projects. The bulk of the funding was provided through a $31,172,774 programmatic solicitation to California electricity suppliers. (Specifically, in June 2001 the Energy Commission awarded $13,649,620 to the Sacramento Municipal Utility District (SMUD); $11,668,572 to Commonwealth Energy Corporation; and $5,854,582 to the Northern California Power Agency and the Public Power Renewable Energy Action Team to develop renewable energy resources that will help make California's electricity more affordable and diversified.) In addition, a sole source contract of $1.3 million was awarded to continue developing a low-cost wind turbine. Two other wind research projects and a distributed generation project also received funding during this reporting period.

- The **Geothermal Resources Development** program area funded several geothermal projects under a targeted solicitation.

- The **Environmentally Preferred Advanced Generation** (EPAG) program area released a solicitation and awarded funds to selected projects totaling $22,850,000. These projects will focus on fuel cells, micro and small turbines (<20MW), fuel cell or turbine hybrid systems, and related technologies. EPAG also awarded $1,758,037 to the University of California at Irvine to advance technology and foster deployment of microturbine generators.

- The **Buildings End-Use Energy Efficiency** program area submitted two proposals to the federal Department of Energy (DOE) for multi-state collaborative research of residential retrofit systems and commercial lighting advancements. In addition, several collaborative research efforts were initiated including the following: a collaboration with other government agencies to develop building energy performance measures, a duct sealing research activity, a partnership with the Lighting Research Center to develop new lighting applications, services, products and policies; and a collaborative with the Association of State Energy Research and Technology Transfer Institutions on indoor air quality.

- The **Industrial / Agricultural / Water Energy Efficiency** program area has undertaken projects with the California Cast Metal Association to lower electric consumption for the cast metal industry; is collaborating with the Petroleum Technology Transfer Center and Electric Power Research Institute (EPRI) to test oil field energy efficiency methodologies; is working with the Lawrence Berkeley National Lab to develop computer-based design tools for building "clean rooms;" examining water/wastewater treatment processes which reduce energy use and minimize environmental problems; and other energy-saving research projects.

- The **Energy-Related Environmental Research** program area focused on the electricity crisis and the immediate need for defining alternative supply options, potential environmental impacts and options for mitigation. Significant projects included establishing a data base of back-up diesel generators, a study of stationary diesel engine emissions control strategies, initiation of a greenhouse gas reduction project; an interagency agreement with the University of California, Irvine, to improve air quality models, testing of an energy-efficient dry cooling technology, and additional air quality projects.

- The **Energy Systems Integration Research** program area (formerly the Strategic Energy Research area) undertook several Research Demonstration and Development (RD&D) projects, including: testing the concept of using intelligent software to control and schedule distributed generation assets within California; conducting a detailed review of conditions on the Pacific Gas and Electric (PG&E) electrical system leading up to the June 14, 2000 collapse of the Bay Area network (in conjunction with the California Independent System Operator (ISO), the Lawrence Berkeley National Lab (LBNL), and PG&E; testing of an advanced load reduction switch that would allow for "soft" blackouts (blackouts only affecting residential 240-volt load); awarding a $1.3 million contract to provide monitoring, data collection and analysis, and reporting for selected distributed energy resource systems to streamline interconnections of these systems to the power grid; and development of research to better understand the structure of the energy market.

- Collaborative research funding awards resulted in 29 research targets with EPRI for $2.15 million and seven projects with the Gas Technology Institute for $0.65 million. The collaborative funding allows the Energy Commission to share the costs and benefits with other research organizations within the United States.

II. PIER PROGRAM AREA FUNDING STATUS

A. Renewable Energy Technologies

1. Programmatic Awards For Renewable Energy RD&D Activities

During this reporting period, the PIER Renewable Energy program area provided over $35.7 million in funding to renewable energy research and development projects. The bulk of the funding was provided through a programmatic solicitation to California electricity suppliers. The electricity suppliers will be developing renewable energy resources that will help make California's electricity more affordable and diversified. However, sole source contracts and interagency agreements were also used in the PIER Renewables program area to support a variety of renewable research activities. These research activities involved projects that will enable California to make better use of the existing renewable electricity facilities in the state; better identify new renewable energy resources in the state; and determine the best possible way to develop these resources to help meet California's electricity needs. In addition, PIER Renewable funding was combined with funding from the Geothermal Resources Development Account (GRDA) in an innovative solicitation that blended geothermal resource development, technology advancement and improved affordability into a single package.

The goal of the PIER Renewables Programmatic Affordability Solicitation is to develop renewable energy resources that will help make California's electricity supplies more diverse and affordable. Funding can be used for assessing and targeting the development of new renewable technologies, for increasing the affordability of existing renewable energy facilities, for accelerating the development of renewable distributed generation systems in high-need areas, and in using renewables to create a customer responsive electricity system of the future. Over $31 million was awarded to three electricity suppliers. Specifically, in June, 2001 the Energy Commission approved an award of $13,649,620 to SMUD; an award of $11,668,572 to Commonwealth Energy Corporation; and an award of $5,854,582 to the Northern California Power Agency (NCPA) and the Public Power Renewable Energy Action Team (PPREAT).

- ***SMUD Program ($13,649,620):***

  With its service area located in the hot Central Valley, SMUD faces a difficult situation of having intense "needle peak" demands, which are driven primarily by high summer temperatures. In addition, SMUD has traditionally purchased about half of its electricity from outside the district, leaving it vulnerable to fluctuating market conditions. The current SMUD program focuses on harnessing more of its electricity from renewable resources indigenous to the SMUD service territory. Over the past several years, SMUD has demonstrated a national leadership role in photovoltaic (PV) solar energy by using a structured manufacturing and installation approach that significantly reduces PV system costs. This program builds off its successes in the PV arena by continuing advancements to PV systems targeted for use by the residential and commercial sectors. However, the SMUD program has expanded its PV focus to include wind and biomass resources available in the SMUD territory. Nineteen projects make up the SMUD program, including 14 which concentrate on PV technologies and markets.

- ***Commonwealth Energy Corporation Program ($11,668,572):***

  Commonwealth's program focuses on developing a set of integrated renewable energy resources that will form a micro-grid capable of meeting special requirements of electricity customers in high-need areas. Commonwealth is using California's Chino Basin to demonstrate that a combination of biogas and building-integrated PV technologies can be used to address both environmental and electricity issues.

- ***NCPA/PPREAT Program ($5,854,582):***

  The NCPA represents a coalition of California public utilities interested in developing renewable energy resources to help meet their future electricity needs. This coalition of over 20 public utilities is known as the PPREAT. Under their proposed program, PPREAT will develop new and advanced renewable energy technology that will enable public power providers to provide thousands of megawatts of clean renewable resource-based electricity to their customers.

  PPREAT's program is a linked research and development program involving five renewable energy resources: biogas from wastewater treatment plants, landfills and dairies; solid biomass resources such as forestry and agricultural residues; geothermal; wind; and solar. The research program encompasses nine projects spread across the state.

2. Sole Source and Interagency Renewable Energy Agreements ($2,923,000)

In addition to the Energy Commission's programmatic renewable energy awards, over $2.9 million in renewable energy research and development funds were awarded during this reporting period using sole source and interagency agreements.

- ***Wind Turbine Company ($1.3 million):***

  The Wind Turbine Company (WTC) was awarded a sole source contract of $1.3 million to continue developing its low-cost wind turbine. The goal of PIER's work with WTC is to develop a wind turbine capable of generating electricity from California's wind resources at a cost less than $0.035 per kilowatt-hour without subsidies. Based on earlier funding support provided by PIER, the federal DOE, and the National Renewable Energy Laboratory (NREL), WTC successfully developed and tested a 250-kilowatt (kw) prototype wind turbine at NREL's National Wind Test Center. Following the successful tests of the 250 kW unit, WTC entered into negotiations with the Los Angeles Department of Water and Power (LADWP) to test a 500-kilowatt WTC turbine within LADWP's territory. Fairmont Reservoir was selected as the test site, and preliminary agreements have been reached between LADWP and WTC. The project represents a necessary and important step in operating a larger-scale WTC wind turbine in a commercial setting representative of California's wind resources.

- ***California Wind Energy Consortium ($375,000):***

  Successfully developing additional California wind resources to act as a valuable, clean, reliable and affordable part of the state's electricity system requires coordination among wind energy developers, environmental groups, electricity suppliers and government representatives.[1] Consequently, the PIER Program is funding the California Wind Energy Consortium to provide a forum for coordination among the California wind industry constituents and to address issues specific to California's unique wind meteorology and topology.

[1] **At nearly 1,700 megawatts, California has the largest developed wind industry of any state in the nation. In addition, wind-generated electricity provides close to 4 billion kW hours of electricity to California ratepayers every year. However, California's untapped wind energy resources could provide up to four times the present wind generating capacity and help address electricity problems facing the state.**

- ***TrueWind Solutions ($150,000):***

  It is difficult to determine the total wind energy potential of the state or where best to continue wind energy development due to limitations on existing wind resource maps. California's last wind resource assessment was conducted nearly 20 years ago using technology and techniques available at that time. As such, the existing resource maps have relatively low resolution and are incapable of providing wind resource estimates through a variety of terrains.

  The TrueWind Solutions project will develop more accurate and appropriate wind resource maps for California using state-of-the-art, proprietary numerical modeling techniques developed by TrueWind Solutions. The high-resolution maps will provide seasonal and annual wind-resource data with terrain and elevation resolution not currently available. The higher resolution and seasonal and annual data are essential for appropriate wind energy resource planning and development. The maps will also be made available to the public in an electronic web-based format.

- ***McNeil Technologies ($730,000):***

  This project focuses on the use of power flow models to investigate the ability of renewable generation systems to address electricity system problems. The transmission and distribution case studies that are developed under this contract will be used in the California Department of Forestry project discussed below. Both contracts are needed to successfully accomplish the goals of this project.

- ***California Department of Forestry ($280,000):***

  The California Department of Forestry (CDF) project focuses primarily on using geographical information system (GIS) tools to investigate the optimal locations for developing renewable distributed generation systems. The GIS models will be based on information regarding terrain, environmental conditions and situations, renewable energy resources, and detailed demographic, environmental, energy use information and results from the power flow analyses.

3. Targeted Renewable Energy Solicitations ($1,928,464)

In June 2001, the Energy Commission awarded $4.7 million, through a targeted solicitation, for geothermal projects in California.[2] The goals of these targeted awards are to help lower the risks and associated costs of developing new

[2] Approximately $2.7 million of these funds came from the GRDA Program and approximately $2 million from the PIER Program.

geothermal resources in California and to help reduce the cost and impacts associated with producing geothermal power. The solicitation represented the combined efforts of the PIER Renewables area and the GRDA Program. Three awards were made on the PIER Renewables portion of the solicitation to: Mammoth Pacific, Lawrence Livermore National Laboratory, and Stanford University.

- ***Mammoth Pacific Lmt. Partnership Project: Evaporative Cooling of Geothermal Power Plants with Reclaim Water ($1 million):***

  The Mammoth Pacific geothermal power plants are three binary power plants using a working fluid (isobutane), that is heated by geothermal hot water into a high energy vapor, which is then used to turn turbine generator sets. The isobutane is condensed after leaving the turbines by air cooling instead of water-cooling. An air-cooled plant produces less power during the warm, dry summer months than does a water-cooled plant. The power plants have a nameplate rating of approximately 32 megawatts (MW). Summer on-peak output can be half of the winter typical output. The Mammoth Pacific project will increase power production by 10 MW or more during summer months by using reclaimed water from the Mono County Water District (MCWD) for evaporative cooling. As a value-added component, the Mammoth Pacific project will send the heated, reclaimed water back to MCWD for direct use applications.

- ***Lawrence Livermore National Laboratory Project: Co-Production of Silica and Metals from Geothermal Fluids ($669,683):***

  The purpose of the Lawrence Livermore National Laboratory (LLNL) project is to develop methods for cost-effectively extracting silica, lithium, and arsenic from geothermal fluids. Silica extraction will be carried out by varying the temperature and pH of the fluid, thereby inducing precipitation of a silica by-product suitable for specific market uses. Lithium and arsenic will be extracted using a new porous silicon nanofilter. If successful, the LLNL project will improve the economics of geothermal energy production by providing an additional income stream from the sale of mineral by-products. In addition, eliminating silica scaling will allow additional energy and heat to be generated from geothermal brines. Finally, the project will also reduce the environmental impacts associated with geothermal energy production by making it possible to efficiently remove toxic metals from spent geothermal fluids.

- ***Stanford University Project: Improving Energy Recovery at the Geysers Geothermal Field by Delineation of In-Situ Saturation ($258,781):***

  The Geysers geothermal field is the largest in the world and represents an important portion of California's electrical power generation capacity. The Geysers is also California's (and the nation's) largest source of renewable energy. Over the past ten years, energy production from the field has been falling as the reservoir "matures." However, wastewater injection into the Geysers has revealed that it may be possible to slow if not reverse the decline in energy production at the Geysers. It is currently not possible to determine the energy production level that will be achieved at the Geysers due to uncertainties in determining the distribution and flow characteristics of the underground geothermal fluids. Similarly, these uncertainties also limit developing an optimal strategy for increased injection of wastewater. The Stanford University project will address the problem of determining the in-place fluid saturation at the Geysers by: (a) making laboratory measurements of saturation on rock cores from The Geysers reservoir, (b) collecting historical field data to infer saturation from model matching, and (c) applying theory and models to estimate saturation from output characteristics. If successful, the project will facilitate more effective recovery of geothermal energy at the Geysers, while establishing the best strategy to prolong its productive life.

B. Environmentally-Preferred Advanced Generation (EPAG)

The deployment of EPAG technologies will provide greater flexibility and control in the delivery of electricity, heat, and shaft power to industrial, commercial, and residential operations. Current predictions are that as much as 20 percent of new electricity generation capacity through the year 2020 will be in the form of distributed, on-site generation.

1. Competitive Solicitation for Fuel Cells, Micro/Small Turbines, and Hybrids

In April 2001, the EPAG team released a solicitation for proposals for RD&D focused on fuel cells, micro and small turbines (<20 MW), fuel cell or turbine hybrid systems, and related technologies. Specific objectives were as follows:

- lower capital cost, installation cost, and/or operation and maintenance cost;
- improve fuel-to-electricity conversion efficiency;
- meet or exceed California atmospheric emissions requirements;
- produce other desirable environmental attributes;

- enhance reliability, durability and maintainability;

- develop multi-fuel use capabilities;

- support integration of distributed generation and on-site generation with the power grid; and

- lead to the adoption and use of the improved EPAG technologies within California.

The following nine projects were approved for PIER awards totaling $22,850,000. The first project is under contract, and the others will have contract start dates beginning in subsequent months.

- ***Alzeta Corporation***

  Alzeta was awarded $2,404,310 for a project titled *Ultra-Low NOx Combustor for a 13.5 MW Turbine Generator.* Total project cost is $3,480,820, with the company providing $1,076,510 in match funding. The project will continue development of an end-use, ultra-low emission combustor that can be retrofitted on a 13.5 MW Solar Turbine gas turbine. The technology avoids the high cost of exhaust gas cleanup, and will be adaptable to other sizes of turbines and other manufacturers. Natural gas-fired combustion turbines are widely used for generating electricity.

- ***Clean Energy Systems Inc.***

  Clean Energy Systems Inc. was awarded $2,003,286 for a project titled *A 500kW Zero-Emission Gas-Fired Power Plant*. Total project cost is $4,049,217, with the company providing $2,045,931 in match funding. The project will demonstrate the long-term reliability of a unique, zero emissions, 500 kW gas generator as it drives a steam turbine to generate electricity at a commercial power plant in Contra Costa County. Exhaust carbon dioxide will be captured for industrial use.

- ***Catalytica Energy Systems***

  Catalytica Energy Systems was awarded $2,997,988 for a project titled *Xonon Ultra-low NOx Combustion in Small Multican Turbines*. Total project cost is $6,392,292, with the company providing $3,394,304 in match funding. The project will develop and demonstrate multi-can catalytic combustion on a gas turbine for ultra-low emissions. The technology has been demonstrated on the single-can combustors of small turbines, but control systems need to be developed for larger multi-can turbines. The results will be adaptable to different turbine manufacturers.

- ***Lawrence Livermore National Laboratory***

  Lawrence Livermore National Laboratory was awarded $3,000,000 for a project titled *Reduced Temperature Solid Oxide Fuel Cells with Direct Oxidation of Natural Gas*. Total project cost is $9,000,000, with the laboratory providing $6,000,000 in match funding. The project will develop a commercially viable Solid Oxide Fuel Cell (SOFC) with high reliability, reduced operating temperature, high power density, low degradation rate, high efficiency, and negligible emissions. A startup company with strong financial backing has obtained licenses from LLNL and is planning to commercialize the fuel cell for electricity generation.

- ***Gas Technology Institute***

  Gas Technology Institute was awarded $2,999,998 for a project titled *Power Module for Multi-Fueled, 10-100 kW Solid Oxide Fuel Cells.* Total project cost is $4,309,202, with GTI providing $1,309,204 in match funding. The project will design, construct and operate a unique, low-temperature, 1-3kW module for a 10-100kW SOFC to produce electricity with negligible emissions. The focus will be on radiative and convective heat transfer, thermal and load cycling performance, reliability, and high efficiency.

- ***ALM Turbine Inc.***

  ALM Turbine Inc. was awarded $2,867,270 for a project titled *Testing, Optimization and Demonstration of an EPAG Microturbine.* Total project cost is $6,272,713, with the company providing $3,405,443 in match funding. The project will use several novel technologies - predominantly developed by Russian engineers now living in the U.S. - to develop a 300kW gas turbine that has high efficiency over a broad power range, low emissions, and low cost. Most gas turbines have high efficiency only at full power.

- ***Solar Turbines Inc.***

  Solar Turbines Inc. was awarded $2,999,644 for a project titled *Catalytic Combustor-Fired Industrial Gas Turbine.* Total project cost is $4,622,649, with the company providing $1,623,005 in match funding. The project will implement cost-effective, low-emission, catalytic combustion in a 5.3MW gas turbine (with applicability to a 4.6 MW turbine). Catalytic combustion avoids costly post-combustion (exhaust gas) cleanup. This project extends a current PIER effort involving Solar Turbines and Catalytica and will speed introduction of the technology into the California market.

- ***GE Energy & Environmental Research***

  GE Energy and Environmental Research was awarded $1,959,013 for a project titled *Integrated DG with PEM Fuel Cell and Autothermal Cyclic Reformer.* Total project cost is $4,000,000, with the company providing $2,040,987 in match funding. The project will continue development of a novel, fuel-flexible, low-cost, efficient, low-emission reformer for generation of hydrogen, that can readily be integrated with a 50kW proton exchange membrane (PEM) fuel cell. Current small-scale reformers are expensive, inefficient, and emit pollutants such as NOx.

- ***Gas Technology Institute***

  Gas Technology Institute was awarded $1,618,084 for a project titled *Partial Oxidation Gas Turbine for Electricity and H_2 Production.* Total project cost is $3,236,167, with the company providing $1,618,083 in match funding. The project will develop and demonstrate a gas turbine with the combustor replaced by a unique partial oxidation reactor. The turbine exhaust can be used as fuel for fuel cells, furnaces, or boilers, resulting in high-efficiency, low-emissions hybrids or combined heat and power systems.

2. Sole Source Award For Environmentally Preferred Advanced Generation

In April 2001, the Energy Commission awarded $1,758,037 of PIER funds to the University of California at Irvine for a three-year contract designed to advance technology and foster deployment of microturbine generators (MTGs) as sources of distributed generation to improve the cost and reliability of California's electricity. The three co-funded projects will help to develop MTGs that can meet strict emissions requirements and operate on various renewable fuel gasses.

The specific objectives of the projects are to (1) design and fabricate a "low BTU" gas module for hydrogen and carbon dioxide and integrate it into a test gas production and handling system for simulating various renewable fuel feedstocks for the testing of MTGs; (2) develop and demonstrate a natural gas-fired combustor for an MTG with low emissions of 1 ppm NOx and >10 ppm CO at 15% oxygen; and (3) develop and demonstrate MTG combustion systems capable of operating on liquid fuels and medium- and low-BTU gas, such as landfill gas or digester gas, rather than natural gas. Work on this sole source contract began during this current reporting period.

C. Buildings End-Use Energy Efficiency

During this period, the PIER Buildings Energy Efficiency Program did the following activities:

- Developed and submitted to the federal DOE two proposals for multi-state collaborative research in the areas of residential retrofit systems and commercial lighting advancements.

- Initiated a multi-state collaborative effort through the Association of State Energy Research and Technology Transfer Institutions (ASERTTI) to develop an energy research plan in the area of indoor air quality (IAQ). The objective of this effort is to identify the highest priority research needs pertaining to the relationship of indoor environmental quality, health, occupant satisfaction, and worker performance with building energy use, including with the building systems and practices affecting energy use. The end product of this effort will be a research plan in the area of indoor air quality. The research plan will include both short (1-5 years) and mid-term (6-10 years) research needs. Developing this plan in collaboration with other ASERTTI members creates the opportunity to bring together core expertise from around the country during the planning process and to proceed with implementing IAQ research in the U.S. in a programmatic, coordinated manner.

- Initiated a multi-California state agency collaboration to develop metrics to better characterize the performance and benefits of energy efficient and sustainable building measures. The goal of this project is to develop tools and methodologies that will enable the State of California Department of General Services to specify, design, deliver, maintain and operate sustainable buildings. This effort will be a partnership between the Energy Commission, the Air Resources Board, Integrated Waste Management Board, Department of Water Resources and the Department of Transportation. This effort is needed to successfully implement the Governor's sustainable building Executive Order.

- Initiated a duct sealing research activity to test the performance and durability of specific products for sealing ducts to increase energy efficiency of thermal distribution systems in California. The goal of this work is to provide information that can be used to improve the success of duct sealing efforts in California buildings. Objective and sound test methods are needed for duct sealing longevity to ensure that duct sealing promotions currently underway in California achieve the energy savings and other consumer benefits possible from this energy efficiency measure. Published results on newly developed duct sealing products will provide helpful information to heating ventilation and air conditioning (HVAC) contractors, duct sealing practitioners, and the general public. The Energy

Commission staff will use duct sealant longevity testing results in their implementation and further development of the Building Energy Efficiency Standards.

D. Industrial/Agricultural/Water Energy Efficiency

During this reporting period the PIER Program's Industrial/Agricultural/Water Energy Efficiency group has undertaken the following activities:

- Lowering Electricity Consumption for the Cast Metal Industry. A contract with the California Cast Metal Association (CCMA) was successfully completed during this reporting period. The contract involved developing new operating procedures for cast metal foundries that depend heavily on electricity. The best operating practices, tested at the most energy efficient operations within the industry, were analyzed for electrical load reduction and load shifting ability. Additional techniques were also developed. The findings from this project were presented to the industry through workshops held in Southern and Northern California. A manual on the operating practices for efficiency and load management was distributed to the industry. An average operation in this industry has a load of 500 kW and 70 percent of this load is for metal melting. If the industry adopts the practices developed through the PIER project, they would reduce load and power consumption 20 percent, thereby reducing the California system load by up to 28 MW and 26 gigawatt hours of electrical consumption. Adopting new operating practices and procedures will enable the industry to better cope with the reliability and price volatility experienced in 2001.

- Improving Oil Field Energy Efficiency. In collaboration with the Petroleum Technology Transfer Center (PTTC) and EPRI, the PIER Program concluded a project entitled "Optimization of Electric Energy Consumption in California Oil Fields." This project established the baseline measurement for determining electrical energy efficiency of oil wells in California. This data was needed for a uniform methodology for assessing energy efficiency. Establishing this efficiency measurement standard will benefit those interested in identifying wells that need improvement. Specifically, the California Public Utilities Commission (CPUC) contractors hired under SB5X to retrofit oil wells that need pump and motor replacements are using information developed under this project. In addition, a workshop for the oil industry was held in Santa Clarita and was attended by several oil well operators from the Los Angeles and Bakersfield areas.

- Improving Energy Efficiency in Clean Rooms for California's High-tech and Bioscience Industries. In May 2001, the Energy Commission entered into a contract with the LBNL to develop computer-based design tools for building clean rooms. Clean rooms are used in pharmaceutical, chemical,

and computer chip manufacturing facilities. They consume an enormous amount of energy to create an environment that is free of particulate and biological contaminants. The design tool will enable California-based industries to build clean rooms that are energy efficient. In addition, the contract will also enable development of an energy efficient fume hood. Fume hoods are commonly used in laboratories and high tech industries for expelling chemical and biological contaminants in the air away from the individual researchers or the manufacturing technician. A typical fume hood consumes the daily energy equivalent of a house, and there are several hundred fume hoods in chemical and pharmaceutical facilities in California. This project would allow the fume hood's electricity consumption to be reduced up to 70 percent with a potential of $30 million per year in energy saving in California. A press event was held at the UC San Francisco campus after successful testing of the prototype fume hood in a laboratory setting.

- Developing Electrotechnology Applications for Potable Water Production and Protection of the Environment. During this reporting period, the Energy Commission received a final report on eight specific tasks to develop alternative water sources and electrotechnologies that could significantly reduce energy use and minimize environmental problems. These reports were funded through a $2.89 million PIER contract with the Metropolitan Water District of Southern California in association with Southern California Edison to address potable water issues.[3]

- R&D to Mitigate Electricity Reliability Problems for California's Electronics and E-Commerce Industry. Electronics and e-commerce industries are a critical component of the California economy. The recent electricity crisis and its adverse impacts on power availability, reliability, and price have severely affected the industry's operations. PIER has provided $960,000 to EPRI to work with the electronics industry in general, and Silicon Valley Manufacturer's Group in particular, to develop a technology road map to provide the industry with tools to mitigate the power reliability, availability and cost issues. An active participation and implementation by the industry is actively solicited.

- Improving Food Processing Energy Efficiency. California's food processors are major users of energy and are a critical part of California's economy. The food processing industry consumes about 5.25 percent of all the electrical energy used in California. It is also a major user of

[3]Southern California, with its sixteen million residents and a dynamic $450 billion regional economy, depends on a reliable and affordable supply of potable water. Most of the current water supply is imported from Northern California or the Colorado River. Water transfer from the north requires significant energy for pumping and major disturbance to the environment. To address these issues, six innovative water/wastewater treatment process technologies were researched and evaluated.

thermal energy. Electricity is primarily used for refrigeration, freezing, fluid separation, water treatment, electrical motors and pumps. PIER contracted with the California Institute for Food & Agricultural Research (CIFAR) to work with the industry to update a 1998 industry energy issues assessment report and recommend energy efficient technology opportunities to mitigate problems created by the recent energy crisis. PIER will fund projects identified under this effort with an active participation by the industry. In addition, CIFAR will develop a technology roadmap that addresses the concerns and issues affecting California's food processing and post-harvest agricultural industry.

E. Energy Related Environmental Research

During the past six months, many PIER Program initiatives in the area of energy-related environmental research focused on activities related to the electricity crisis. Several projects were approved because of the immediate need for defining alternative supply options; potential environmental impacts and options for environmental impact mitigation. Although resources were diverted to these activities, progress was made in the core areas of air quality, aquatic resources, land-use/habitat and global climate change.

The following are some highlights of the research activities newly initiated or being conducted in the environmental research area:

- In response to the recent electricity crisis, the Energy-Related Environmental Research team made a major effort to identify and evaluate the environmental impacts of additional electricity supplies (in particular, the potential generating capacity and likely impacts to air quality and public health from back-up diesel generators.) As a result of this PIER project, a database of back-up generators was established and is available at:

  www.energy.ca.gov/database/index.html#bugs

- In a related project, research to determine the effectiveness of stationary diesel engine emissions control strategies was initiated with the University of California, Riverside. This project is examining the environmental implications of back-up diesel generator use during electricity supply shortages. In addition, a testing program was initiated to identify emerging control technologies, test performance, and assess the potential for reducing emissions. This testing will provide valuable information to a planned regulatory initiative at the Air Resources Board (ARB). The amount of this Interagency Agreement is $1,500,000.

- A "Greenhouse Gas Reduction" project was initiated to provide support in the implementation of Senate Bill 1771, which mandates the creation of an "early action" registry for companies that reduce greenhouse gas emissions. Under

this PIER project, methodologies are being developed to establish an emissions baseline for key industries and determine how emissions reductions should be calculated for reporting to the Registry. LBNL is conducting the research for this project. The funding level is $228,000.

- An Interagency Agreement with the UC at Irvine was initiated to improve existing three-dimensional air quality models and examine the regional and overall air quality impacts of widespread distributed generation applications in California. The amount of this Interagency Agreement is $698,689.

- In conjunction with EPRI, contractors have been conducting tests on the effectiveness of a spray enhancement system installed at a cogeneration facility utilizing dry cooling.[4] Spray enhancement provides a low-cost mechanism to reduce energy losses associated with dry cooling technology and high summer temperatures common in California. Initial test results are very encouraging. A final report is anticipated by the end of the year. The amount of this project is $285,000.

- UC Riverside submitted a PIER draft final report entitled "Quantification of Uncertainties in Continuous Measurements Systems for Low NOx Emissions from Stationary Sources." In September, the draft report was presented to the Low Emissions Measurement Committee (LEMC) headed by Air Resources Board (ARB).[5] The report was well received, and the Environmental Protection Agency is planning to use this report to establish new source test and continuous emission monitoring (CEM) requirements. These requirements will eventually affect power plants in California. ARB is planning to review its power plant guidance document using, in part, the results in this report. The amount of this project is $137,200.

- Existing regulatory source test methods may overstate direct PM emissions from gas turbines by a wide margin. As part of the *Fine and Ultrafine Particulate Matter Study* initiated in April 2001, researchers funded by PIER, the federal DOE, the New York State Enegy Research & Development Agency (NYSERDA), and the Gas Research Institute tested a modern combined cycle power plant in California. They used a dilution tunnel developed at CalTech and enhanced by Desert Research Institute to measure actual direct particulate matter (PM) emissions. This research is part of a three-year project designed to produce information needed by the regulatory agencies to adopt a better PM source test method. Both the Environmental Protection Agency and ARB are involved in this project. The amount contributed by PIER for this project is $725,000.

[4] Dry cooling can reduce a combined-cycle power plant's water requirements by as much as 95% but can also lead to increased fuel consumption at the plant.

[5] Representatives of instrumentation manufacturers, power plant owners, gas turbine manufacturers, source test groups, and regulatory agencies form the LEMC.

F. Energy System Integration Research

During this reporting period, the Energy System Integration Research program area team undertook the following RD&D projects:

- Improving Distributed Generation

  In August 2001, the Energy Commission awarded a $499,970 contract to Alternative Energy Systems Consulting Inc. to test and prove the concept of using Intelligent Software Agents for control and scheduling of distributed generation assets at multiple sites within California. This project will continue research begun under PIER contract number 500-98-040 with the same contractor. Under the initial PIER contract, the contractor successfully completed a $554,010 research effort to determine the feasibility of using Intelligent Software Agents for control and scheduling of distributed generation assets.

  This follow-on contract will demonstrate use of intelligent software agents for control and scheduling of one or more distributed energy resources (DER) in a competitive energy market, and the will provide demonstration software that can be used to transfer this technology into the energy industry. This enabling technology will make it cost-effective to have a transmission grid-connected generation source available for dispatch by the ISO. The software allows the generator to be unmanned and remotely dispatched. This software will also work for curtailable loads.

  The initial PIER funded project brought this technology through the bench testing/proof of concept phase of development and it is now ready to start the technology development and field experiment phase. The main work that will be accomplished during this project is to develop the interfaces that allow the software to operate with a wide variety of equipment in the marketplace. After the interfaces are developed, a feasibility field test with a variety of equipment and various participants will be performed. This feasibility field test will provide the necessary data on potential savings to entice customers to use this new technology in their products and operations.

- Improving Energy Systems Analyses

  The Energy Commission and the California ISO, in cooperation with the LBNL and PG&E, asked Optimal Technologies to perform a detailed review of conditions on the PG&E electric power system leading up to the June 14, 2000 collapse of the Bay Area network (which resulted in emergency rotating blackout of over 140 MW and impacted approximately 100,000 homes and businesses). The principal purpose of this $200,000 PIER-funded study was to evaluate the capabilities of Optimal Technologies' network optimization software (Aempfast), currently under

development, by applying it to well-documented circumstances in which a power system was under acute stress. The Energy Commission, ISO, LBNL and PG&E provided the data to be analyzed and personnel to serve as a Technical Review Committee.

Optimal Technologies was asked to use Aempfast to review certain ISO and PG&E decisions made on June 14, 2000 regarding the amount of load shed necessary to have prevented voltage collapse on the Bay Area network, the proper location for monitoring system voltage levels, and the correct trigger point for ordering emergency load shedding to prevent system collapse. The contractor was to assume the availability and control only of system resources available to the ISO and PG&E on that date.

Using Aempfast, the contractor found that on June 14, 2000, the Bay Area network in fact had sufficient generation and other resources (including transmission and distribution resources) to have withstood voltage collapse without any load shedding had measures now identified by their software been implemented. The contractor also found that with the tools and the data available to them, the ISO and PG&E made appropriate decisions on June 14, 2000 regarding the amount of load to be shed, the system monitoring point, and the voltage level at which to commence load shed.

- Evaluating Advanced Switches for Soft Blackouts

  In May 2001, the Energy Commission awarded an $800,000 contract to California State University Chico Research Foundation to test an advanced load reduction switch that would allow for soft blackouts, that is, blackouts only affecting residential loads of 240-volts or greater. These switches would potentially alleviate many of the seriously negative aspects of total blackouts such as inoperable traffic signals.

  These devices would primarily be installed on residential transformers and not commercial or industrial services. A desirable feature of this invention is that during hot weather, for instance, sufficient load reduction can be achieved by cutting off large numbers of home air conditioners in such a way that factories and businesses are not affected. Rolling blackouts do not need to be done that cut off all places of employment in order to cut off unessential or unused home appliances in the same region. Since the switch would be located in or near a transformer enclosure or meter socket, another advantage of the switch would be the inability to physically disable the switch.

  The switch is still in the concept stage, and no field-ready device suitable for utility installation exists. This phased research program with California State University Chico Research Foundation over the next several months

will identify critical issues such as: coordination between switch operation and transmission and distribution system controls, possible neutral overloading or transformer overheating, whether the switch can withstand the expected operational and environmental conditions, the impact on appliances and equipment within the residence and possibly to other residences connected to the same transformer. Testing will be conducted to measure the interaction of the switch with typical residential loads, determine their suitability for utility application, and evaluate the operational implications of using this switch.

- Improving Interconnections For Distributed Energy Resources (DER)

  In May 2001, the Energy Commission approved a $1,364,787 PIER contract with Reflective Energies to provide a program of monitoring, data collection and analysis, and reporting for selected DER systems. The purpose of this contract is to streamline interconnections of these DER to the utility distribution system and reduce the associated costs of doing so. This contract will further work initiated in the FOCUS I contract (PIER Contract Number 700-99-010) which resulted in the successful adoption of the Rule 21 interconnection standards.

  The goal of FOCUS-II is two-fold: bring more projects under the "simplified" interconnection umbrella developed in the previous FOCUS I contract and ease concerns of DER's impact on the distribution system. Revised Rule 21 requirements have created a framework for improving the interconnection process and reducing cost. "Simplified" interconnection applications cost only $800. These are presently defined as installations that use certified equipment, do not export power, do not generate more than 15 percent of the distribution line's peak load or are less than 11 kVA in capacity size. All other applications including ones where the DER system operates in parallel with the electrical distribution grid temporarily or exports power to the grid cost $1,400 or more.

- Exploring Alternative Electricity Market Structures for California

  One of the areas currently being funded by the Energy Systems Integration team is research to better understand the market structure(s) within which electricity transactions occur, evaluate the performance of these markets and associated signals for technological innovation, and identify how electricity related technologies may function within these markets. To further California's understanding of this topic, during this reporting period, PIER sponsored a workshop to focus on the relationship between market structure and reliability.

III. PIER COLLABORATIVE RESEARCH FUNDING STATUS

PIER funding of collaborative efforts headed by other energy research organizations allows the Energy Commission to participate in many state wide and national RD&D activities, thus allowing California to provide input and receive benefits from these broadly funded RD&D efforts.

During the current reporting period, the Energy Commission reached an agreement with EPRI concerning a new collaborative research project entitled "RD&D Program Development for Ensuring Energy Supply for California's Electronics/E-Commerce Industries". The project description is detailed on page 14.

IV. ENERGY INNOVATIONS SMALL GRANT FUNDING STATUS

Through the PIER-funded Energy Innovations Small Grant Program, the Energy Commission has released nine solicitations to date. For the first seven solicitations, the Energy Commission has approved 61 projects totaling over $5.2 million. During the current reporting period, the Energy Commission approved 20 small grants for a total of $1,486,983 and additional grants from an additional solicitation (conducted in October 2001) are awaiting Energy Commission approval. The complete status of the PIER Small Grants Program is summarized in the table on the following page.

Energy Innovations Small Grant Program Funding Summary					
Solicitation	Release Date	Due Date	Business Meeting Date	Grants Awarded	Funded
99-01	3/31/99	4/30/99	8/11/99	13	$973,966
99-02	4/30/99	5/31/99	11/17/99	5	$374,595
99-03	8/30/99	9/30/99	1/26/00	11	$824,530
99-04	12/17/99	1/28/00	7/12/00	10	$741,769
00-01	3/15/00	4/28/00	9/20/00	7	$524,751
00-02	6/15/00	7/28/00	12/20/00	11	$818,194
00-03	8/31/00	10/31/00	3/21/01	4	$297,315
00-04	12/30/00	1/31/01	6/27/01	11	$812,446
01-01	3/2/01	4/30/01	10/31/01	9	$674,531
01-02	10/5/01	11/16/01		Pending	

To date, two small grant projects which successfully established early concept feasibility have gone on to seek and receive follow-on PIER funding of more than $4.4 million.

V. OTHER PIER PROGRAM ACTIVITIES

A. PIER Information Exchanges and Technology Transfer

Providing accurate information and assisting in technology transfer are critical to the success of any RD&D effort. Accordingly, during the current reporting period, the PIER Program performed the following activities:

PIER co-sponsored and co-planned an Industry Growth Forum (IGF) with the NREL. The IGF was held November 5-7, 2001 in San Jose. This was the first IGF held in California and focused on California-based clean energy businesses and technologies. Venture capitalists and "angel investors" from throughout the country served as panelists for the IGF, which also included two PIER-funded projects seeking capital funding: Energy Savers International (low-cost controller technology for air conditioners and heat pumps); and the Wind Turbine Corporation (lower-cost utility scale wind turbine).

During this reporting period, the Energy Commission continued its collaborative efforts with Science Applications International Corporation (SAIC) to redesign the PIER Program website. The PIER staff provided program information to SAIC for input into the new Web Site. The new PIER website, originally scheduled to go live July 1, 2001, was delayed and will now debut December 1, 2001.

The PIER Program recently co-sponsored and PIER staff participated in a number of technology transfer events and activities, including the following:

- Co-sponsored and spoke at UPEx '01, the annual conference of the Solar Electric Power Association from September 30-October 5, 2001, in Sacramento

- Co-sponsored and spoke at the annual CADER meeting, the California Alliance for Distributed Energy Resources, November 1-2, 2001, in San Diego

- Presented a paper at the Association of State Energy Technology Transfer Institutes (ASERTTI) fall meeting in Chicago on October 10, 2001

- Co-sponsored, spoke at and served on a panel for DOE's *"Energy Solutions for California Industry: Ways to Improve Operations and Profitability"* in Sacramento on August 14, 2001

- Co-sponsored *"Hydrogen Pinch Technology for Optimizing the use of Hydrogen in California Refineries"* workshop May 3-4, 2001, in Long Beach

- Presented a paper *"Benchmarking of Electricity Consumption in the California Oil Field and the Causes of Inefficiency"* at the Quarterly Meeting of the Petroleum Technology Transfer Center July 18, 2001, in Santa Clarita

- Presented a paper *"Clean-room Energy Benchmarking in High-tech and Biotech Industries in California*" at the 2001 Summer Study Conference sponsored by the American Council for an Energy Efficient Economy in Tarrytown, New York, on July 25-28, 2001

- Co-sponsored and spoke at the Lawrence Berkeley National Laboratory press event for the PIER-funded Fume Hood demonstration and unveiling at UC San Francisco, on August 31, 2001

- Presented a paper at the Electric Power Research Institute (EPRI) Distributed Resources Target Advisory Committee meeting in Knoxville, Tennessee, on October 17, 2001

- Served on a review panel for the DOE's Geothermal Energy Program Geoscience Peer Review in San Diego, on August 23-24, 2001

- Established the California Advanced Reciprocating Internal Combustion Engines (ARICE) collaborative with over 200 stakeholders; first workshop held July 10, 2001, in Sacramento

- Presented a paper titled *"California Advanced Reciprocating Internal Combustion Engines Collaborative: Purpose, Mission, Goals and Targets and Action Plan"* at the 7th Diesel Engine Emissions Reduction (DEER) workshop in Portsmouth, Virginia, on August 5-9, 2001

- Co-sponsored and spoke at the Esource meeting on October 16, 2001 in Colorado Springs, Colorado

- Co-sponsored the ASHRAE annual meeting on June 24-27, 2001 in Cincinnati, Ohio

- Co-sponsored and spoke at the Lighting Research Center meeting on June 11, 2001 in Troy, New York

- Co-sponsored the Center for the Built Environment meeting in Berkeley on October 18-19, 2001

- Co-sponsored the California Commissioning Collaborative meeting on August 17, 2001, in Sacramento

- Presented a paper at the 4th Eurasian Congress on Raptors titled *"California Energy Commission's Public Interest Energy Research Program: Funding Solutions to Raptor Interactions with Utility Structures"* on September 25-29, 2001 in Seville, Spain

- Presented a paper and served on a panel at the EPRI 2001 Continuous Emission Monitoring Users Group Meeting in Charlotte, North Carolina, on May 16-18, 2001

- Made a presentation at the Professional Environmental Marketing Association meeting on Environmental Opportunities in Relation to the Current and Future Energy Market in California, held May 22, 2001, in Berkeley

- Hosted a public workshop on R&D needs for integration issues facing distributed energy resources August 29, 2001 in Sacramento.

During this reporting period the PIER Program staff also began planning for its co-sponsorship of the fourth annual "International Colloquium and Exhibit on Environmentally Preferred Advanced Energy Generation (ICEPAG)" to be held February 4-7, 2002 in Southern California.

B. PIER Success Stories and Other Reports

The PIER Program staff has produced the first in a series of "PIER Success Story" fact sheets. PIER projects showcased include the following:

- PowerLight PV manufacturer

- Alzeta low NOx turbine

- Berkeley lamp

- Distributed generation interconnection streamlining

- Energy efficient fume hood technology

The PIER staff also commenced work on the *Fourth Annual PIER Report to the Legislature*, which is due on or before March 31, 2002. The annual report will provide detailed information all PIER activities that occurred during the 2001 calendar year, as required by law.

VI. CONCLUSION

The Energy Commission remains fully committed to administering the PIER Program in an efficiency and effective manner that ensures public input and accountability. The PIER section of the Energy Commission's website is a means of communicating with stakeholders and the public. The website and all reports can be accessed at:

www.energy.ca.gov/research/PIER/index.html